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Vedr. **patentansøgning**

Hermed fremsendes pr. fax en patentansøgning vedr. en **Method for determining position of objects in front of a monitor.** Ansøgningen fremsendes efterfølgende pr. post.

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Kvittering for modtagelsen bedes mærket **"position detection"**

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Method for determining position of objects in front of a monitor

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Method for determining position of bjects in front of monitor

Aalborg University, December 7th 1999
By Anders la Cour-Harbo and Jakob Stoustrup

Introduction

In many applications it is desirable to operator an apparatus equipped with a monitor without using a keyboard or the like. It is commonly known that a touch screen is a solution to this problem. The idea of the touch screen is that both information and "buttons" are located on the screen, and that the screen is sensitive to touch in two or three dimensions, that is the position on the screen – and possibly the pressure – of the touching object is determinable. We propose a method for acquiring that same information without the need for physical contact. Pressure is replaced by distance to the screen. The method relies on the ability of the screen to emit light (or indeed any kind of signal that can be modulated, like electromagnetic or acoustic waves) which can changes spatially and/or temporally. That is the emitted signal can change location on the screen and/or vary in time. This requirement is for instance fulfilled by any TV or computer monitor. We propose two different approaches; one where parts of or the entire screen is continuously illuminated, and one where the objects are tracked as they move.

Key words: Monitor, wavelet, touch screen, touch-free (screen).

Description of the idea

We want to determine the position of one or more objects located in the immediate vicinity of the front of a monitor. In the following we will refer to one or more objects as "object". This object would typically be a finger or a pen, or another object of relatively little spatial extension in directions parallel to the monitor plane. We propose to do this by letting the monitor itself illuminate the object with some kind of signal, which depends of the capabilities of the monitor. This would typically be an electromagnetic signal within a limited range of frequencies. Alternatively a dedicated monitor for the purpose described could be used. Such a monitor would for instance emit auxiliary signals in predetermine, suitable frequency ranges, such as infra red and ultra-violet. For any monitor, at locations around it, a number of receivers is positioned. The emitted light is reflected by the object onto these receivers, thus making it possible to determine the position of the reflecting object.

There are basically two different ways of doing this. Either the timing of the updating of the image on the monitor can be used, or the distances between the reflecting object and receivers can be used. The former relies on the typical method for updating monitor images, which is sequential excitation of each pixel on the monitor. Whenever the pixels close to the object are updated the change in the state of these pixels (typically originating in the beam of electrons used to excite the pixels) is reflected by the object onto the receivers. Since it is known when each pixel is excited it is possible to determine the position of the reflecting object. This method requires synchronization of the monitor image updating and the signal processing of the received signals.

The other method is via measurements of the distances between the object and the receivers. If the absolute distances between the object and at least two (in some cases three) receivers are known, it is a relatively simple matter to determine the position. The distances can be found through time-of-flight, triangularization, relative distances based on reflected intensity, or some other mean. The relative

distance approach requires one extra receiver, and advanced signal processing. More receivers can be added to increases accuracy and robustness.

The method that use distances between the object and the receivers can be implemented in two different ways, as mention in the introduction. One methods is to illuminate parts of the screen (or the entire screen) either at once or each pixel (or sets of pixels) sequentially (with for instance a vertical line moving across the screen). Another method is to track the object in the sense that a number of pixels in the vicinity of the object illuminates. When the object moves the illumination follows.

It will further be possible to do some intelligent denoising combined with determination of the quality of measurements. The extend of this is determined by the positioning method chosen. By spatial and/or temporal modulation of the illumination, the colour, and the intensity, the emitted signal can be assigned some distinct features making it both separable from signals from external sources and suitable for a quality measurement.

Hierarchy of general proposals

We propose:

1. Apparatus for determining the position of one or more objects in the vicinity of the front of a monitor, comprising
   (a) A monitor capable of illuminating the object with for instance electromagnetic or acoustic waves.
   (b) A number of receivers located around the monitor.
2. Apparatus as defined in proposal 1 where the reflected signal is generated by the process which updates the pixels on the monitor.
3. Apparatus as defined in proposal 1 where the reflected signal is generated by illumination of one or more pixels, either simultaneously or sequentially.
4. Apparatus as defined in proposal 1 where the monitor itself is designed with the ability to produce auxiliary signals.
5. Apparatus as defined in proposal 3 and 4 where the illuminating pixels constitutes a fixed or variable geometrical shape which follows a predetermine course on the monitor independent of the object.
6. Apparatus as defined in proposal 3 and 4 where the illuminating pixels constitutes a fixed or variable geometrical shape the movement of which depends on the reflecting object.
7. Apparatus as defined in proposals 5 and 6 where the illumination signal is modulated spatial and/or temporal.

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